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MISCELLANEOUS.

Conducted by J. M. COLAW, Monterey, Va. All contributions to this department should be sent to him.

SOLUTIONS OF PROBLEMS.

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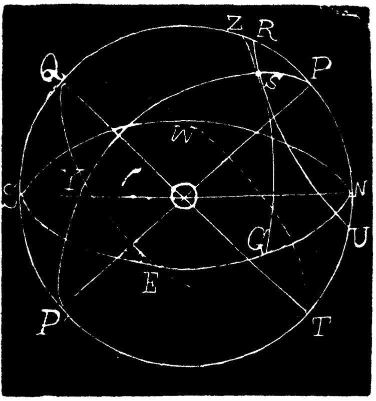
17. **Proposed by SAMUEL HART WRIGHT, M. D., M. A., Ph. D., Penn Yan, Yates county, New York.**

A bright star passed my meridian at 7 P. M. The Chronometer soon after ran down and stopped, but I set it again when the same star had a true altitude of $30^\circ=\alpha$. What time was it then, my latitude being $42^\circ\ 30'$ *N.* $=\lambda$, and the star's Declination 60° *N.* $=\delta$?

Solution by G. B. M. ZERR, A. M., Principal of High School, Staunton, Virginia.

Let O be the place of the observer, Z his zenith, $SENW$ the horizon, P and P' two poles of the heavens, $EQWT$ the celestial equator. S the star. YS the star's declination. $\angle SPZ$ the star's hour angle=arc QY, $SZPN$ the meridian. ZSG arc of star's vertical arc, SG star's altitude. From the spherical triangle ZPS we get $\cos ZS=\cos PS\cos PZ+\sin PS\sin PZ\cos ZPS$. But $ZS=90^\circ-\alpha$, $PS=90^\circ-\delta$, $PZ=90^\circ-\lambda$, $\angle ZPS=h$.



$$\therefore\ \cos h=\frac{\sin\alpha-\sin\lambda\sin\delta}{\cos\lambda\cos\delta}$$

$$=\frac{\sin 30^\circ-\sin 42\tfrac{1}{2}^\circ\sin 60^\circ}{\cos 42\tfrac{1}{2}^\circ\cos 60^\circ}$$

or we might use the formula

$$\sin^2\tfrac{1}{2}h=\tfrac{1}{2}\,\frac{\cos(\lambda\sim\delta)-\sin\alpha}{\cos\lambda\cos\delta}$$

$$=\tfrac{1}{2}\frac{\cos 17\tfrac{1}{2}^\circ-\sin 30^\circ}{\cos 42\tfrac{1}{2}^\circ\cos 60^\circ}.\quad h=103^\circ\ 20'\ 37''.93$$

$$=6\text{ hr. }53\text{ m. }22.53\text{ sec.}$$

$\therefore$ time=53 m. 22.53 sec. after 1 o'clock A. M.

In the figure the star is east of the meridian while in its true position it is west of the meridian.

Also solved by *Professors MATZ, SCHEFFER, WHITAKER and the PROPOSER.*

18. **Proposed by M. C. STEVENS, A. M., Professor of Mathematics, Purdue University, Lafayette, Indiana.**

"Show generally that a system of confocal conics is self-orthogonal."—*Johnson's Differential Equations.*

Solution by WILLIAM WOOLSEY JOHNSON, M. A., Member of the London Mathematical Society, and of the American Mathematical Society, Professor of Mathematics in the United States Naval Academy, Annapolis, Maryland:

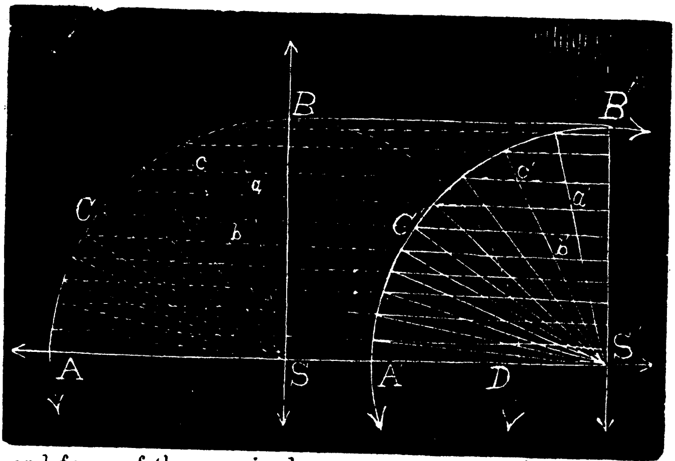
The equation of a system of confocal conics, foci at ($\pm c$, 0), is $\dfrac{x^2}{a^2}+\dfrac{y^2}{a^2-c^2}=1\ldots.(1)$, a being the arbitrary constant. Differentiating, and putting p for dy/dx, $\dfrac{x}{a^2}+\dfrac{yp}{a^2-c^2}=0$, or $a^2(x+yp)=c^2x\ldots.(2)$. Eliminating a between (1) and (2), $\dfrac{x(x+yp)}{c^2}-\dfrac{y(x+yp)}{c^2p}=1$, or $xyp^2+(x^2-y^2-c^2)p-xy=0$ $\ldots.(3)$, which is the differential equation of the system. Putting $p=-\dfrac{1}{p'}$, we have $xyp'^2+(x^2-y^2-c^2)p'-xy=0\ldots.(4)$, which is the equation of the trajectory when $p'=dy/dx$, and it is identical with equation (3). In other words, the roots of equation (3), as a quadratic for p, are negative reciprocals.

Also solved by *Professors MATZ and ZERR.*

19. Proposed by F. P. MATZ, M. Sc., Ph. D., Professor of Mathematics and Astronomy in New Windsor College, New Windsor, Maryland.

A spherical shrapnel-shell is moving in a horizontal direction, with a constant velocity $V_1=1500$ feet per second. The shell explodes at a height $h=\frac{1}{2}g$; and the fragments of the shell and the balls inclosed by the shell, are *equably* scattered with a uniform velocity $V_2=1200$ feet per second. Draw the curve bounding *the minimum surface on the earth* on which the fragments of the shell and the balls inclosed by the shell, have fallen.

Solution by the PROPOSER.



The path of the shell is an inverted catenary of equal (or uniform) strength. At the point of maximum altitude of the path, $h=\frac{1}{2}g$, the shell moves in a horizontal direction. Ignore all such *complicating factors* as the resistance of the atmosphere, the rotary motion and geodesic contour of the earth, etc., as practically nugatory in so far as the position and form of the required curve are concerned. The range of the shell can now be determinately or approximately deduced. The determination of the *maximum range* of the fragments of the shell and the balls inclosed by the shell, is the next step preliminary to the drawing of the required curve. In the problem under consideration, the position of the shell at the instant of explosion is at some (unrepresented) point P vertically above S and perpendicular to the plane of the circle whose center is at S; that is $PS=h=\frac{1}{2}g$ $=16\frac{1}{12}$ feet. The fragments a, b, c, resulting from the explosion of the shell.